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# **Construction Of Electric Cargo Tricycle In Nigeria: Design, Implementation And Challenges**

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## **ABSTRACT**

The rise in urbanization and environmental concerns has led to a growing interest in sustainable and efficient transportation solutions. The increasing demand for cost-effective, environmentally friendly, and efficient means of urban and peri-urban transportation has intensified interest in electric mobility solutions. This study focuses on the construction of an electric cargo tricycle, emphasizing its design, implementation, and associated challenges in Nigeria. The research adopted a practical engineering approach involving conceptual design, component selection, fabrication, assembly, and performance evaluation of the tricycle. Key design considerations included load-carrying capacity, energy efficiency, safety, affordability, and suitability for local operating conditions. The electric cargo tricycle was powered by a rechargeable battery system coupled with an electric motor and a motor controller, with attention given to structural strength and stability. Performance tests were conducted to assess speed, load capacity, range, and overall functionality. Despite achieving satisfactory operational performance, several challenges were encountered, including battery limitations, component availability, cost constraints, and technical integration issues. The study demonstrates that electric cargo tricycles are a viable alternative to conventional fuel-powered tricycles for short-distance cargo transportation, with significant potential for reducing operational costs and environmental pollution

**Keywords:** Electric cargo tricycle, Construction, Utilization, Logistics, Sustainability, Impact.

## **INTRODUCTION**

Electric cargo tricycles are three-wheeled vehicles powered wholly or in part by electric propulsion systems: emerging and promising alternatives for short-distance logistics and last-mile delivery systems in urban environments. These vehicles combine electric propulsion with cargo-carrying capacity to address the inefficiencies associated with conventional internal combustion vehicles, such as high emissions, noise pollution, and traffic congestion. An electric cargo tricycle's design focuses on

efficiency, maneuverability, and sustainability to support urban logistics and reduce reliance on traditional automotive transport solutions (Bolaños et al., 2024). Early research indicates that such vehicles can significantly improve load-carrying operations while reducing greenhouse gas emissions, enhancing operational efficiency and supporting sustainable urban transport strategies. According to Hossein (2012), research efforts have explored different aspects of electric cargo tricycles, including design for waste collection, last-mile delivery, and urban logistics. However, despite these advantages, the adoption and implementation of electric cargo tricycles are challenged by technological, infrastructural, and socioeconomic factors. Research on electric three-wheelers includes broader industry analyses revealing issues such as inadequate charging infrastructure, regulatory barriers, component supply dependencies, and limited public awareness—all of which influence market growth and technological adoption (Mastanamma, 2025).

In recent years, cities worldwide have seen an unprecedented increase in both population and vehicle usage. Urban areas, especially in densely populated regions, are facing major challenges related to traffic congestion, air pollution, and the rising cost of transportation. Traditional cargo vehicles, typically powered by internal combustion engines, contribute significantly to these problems, emitting harmful pollutants and occupying valuable urban space. To address these issues, there has been a growing shift towards more sustainable forms of transportation, including electric vehicles (EVs) and electric cargo tricycles (Xie & Wang, 2020). Electric cargo tricycles are a promising innovation, offering an eco-friendly alternative for transporting goods in cities with limited road space. These tricycles combine the benefits of electric propulsion with the stability and carrying capacity of a three-wheeled vehicle, making them an ideal choice for last-mile delivery and small-scale urban logistics. However, despite these advantages, the adoption and implementation of electric cargo tricycles are challenged by technological, infrastructural, and socioeconomic factors. Research on electric three-wheelers includes broader industry analyses revealing issues such as inadequate charging infrastructure, regulatory barriers, component supply dependencies, and limited public awareness: all of which influence market growth and technological adoption (Wikipedia, 2026).

Urban centers worldwide face growing challenges with transportation and logistics due to rapid urbanization and increased demand for efficient goods delivery. Three-wheeled vehicles including auto-rickshaws and cargo tricycles have long served as affordable and flexible transport modes, particularly in developing regions. The shift toward electric propulsion in these vehicles is driven by environmental concerns and the need for sustainable transport options that align with climate mitigation goals and urban mobility policies (Hossain et al., 2024). Studies in sustainable urban transport underscore the role of electric three-wheelers in reducing carbon emissions and supporting low-emission transport strategies in developing cities. The concept of electric cargo vehicles is not new, but the growing emphasis on sustainability, the availability of advanced battery technologies, and government incentives for clean energy solutions have revived interest in these alternatives. Electric cargo tricycles offer several advantages over traditional delivery methods, including reduced greenhouse gas emissions, lower operational costs, and enhanced maneuverability in congested urban environments (Zhang & Yang, 2021). Historically, three-wheeled vehicles have been used for transportation in both rural and urban areas, particularly in countries like India and China, where they are commonly used for small-scale delivery tasks. However, the transition to electric propulsion has only been more recent, driven by advances in electric motor technology, battery efficiency, and regulatory pressure for cleaner transportation options.

### **Problem Statement**

Although electric cargo tricycles present significant potential for sustainable urban transport and last-mile logistics, their widespread implementation remains hindered by several challenges:

1. **Design and Technical Challenges:** Ensuring vehicle stability, structural integrity, and adequate cargo capacity while integrating efficient electric power systems continues to be difficult due to inherent limitations in three-wheeled configurations and powertrain integration.

2. Infrastructure Limitations: Charging infrastructure remains underdeveloped in many regions, particularly in emerging markets where last-mile delivery demand is highest, constraining operational efficiency and range reliability (Esheya et al., 2025).
3. Regulatory and Market Barriers: Diverse regulatory environments, certification requirements, and inconsistent policy support create barriers for vehicle manufacturers and operators, affecting adoption rates.
4. Socioeconomic Constraints: Financing, consumer awareness, trained technical workforce, and market support mechanisms lag behind the technological potential of electric cargo tricycles, reducing their competitiveness against conventional vehicles (Hamride, 2025).

Together, these challenges restrict the practical scalability of electric cargo tricycles in urban transport systems and impede their broader contribution to sustainable logistics solutions. Thus, this research aims to address the gaps identified above. The primary problem addressed by this study is how to design and construct an electric cargo tricycle that can: effectively replace internal combustion engine (ICE) vehicles for urban logistics and last-mile delivery; overcome the common challenges of electric vehicles, including limited range, high initial costs, and slow adoption; provide a cost-efficient, environmentally friendly, and reliable solution to meet urban freight demands. Thus, this paper aims to investigate the construction of electric cargo tricycles, providing insights into their design, key components, and the challenges involved in their development. By examining the feasibility of these vehicles in urban settings, this study seeks to contribute to the growing body of knowledge on sustainable urban transport solutions. The solution proposed in this paper aim to address these challenges and demonstrate the practical feasibility of electric cargo tricycles.

### **Scope of the Study**

This study focuses on the design and construction of electric cargo tricycles, specifically aimed at urban transportation. The scope of this paper includes:

5. Chassis Design: Material selection, structural integrity, and cargo space considerations.
6. Powertrain Development: Motor selection, drivetrain configuration, and efficiency analysis.
7. Battery and Charging Systems: Battery technology, range estimation, and charging infrastructure.
8. Control and Electronics: Integration of throttle, braking systems, and power management systems.
9. Challenges in Construction: Addressing issues such as cost, battery life, and infrastructure needs.
10. Impact on Urban Logistics: Examining how electric cargo tricycles can reduce congestion, emissions, and operational costs.

This study does not extend to the commercial production or detailed cost analysis of electric cargo tricycles, although these aspects may be touched upon as part of the discussion.

## **LITERATURE REVIEW**

### ***Electric Cargo Vehicles in Urban Logistics***

A growing body of research suggests that electric vehicles (EVs), including electric cargo tricycles, can significantly reduce carbon emissions and operational costs compared to traditional gasoline or diesel-powered vehicles. According to Lee et al. (2021), electric vehicles offer environmental benefits such as a reduction in CO<sub>2</sub> emissions and pollutants like NO<sub>x</sub> and particulate matter, which contribute to air quality problems in urban areas.

### ***Design and Components of Electric Cargo Tricycles***

A review of the literature shows that the design of electric cargo tricycles must balance several factors, including payload capacity, power output, and battery life. Xie and Wang (2020) highlight that the frame of an electric cargo tricycle must be both lightweight and durable, with a robust chassis capable of handling the stresses of heavy loads and varying road conditions. Furthermore, battery systems are often cited as one of the most critical factors influencing the performance of electric cargo tricycles (Zhang et al., 2022).

### ***Battery Technology and Range Limitations***

Lithium-ion batteries are currently the most commonly used energy storage system for electric cargo vehicles. However, researchers like Gupta et al. (2019) point out that battery life, energy density, and charging time remain significant challenges. Li-ion batteries, though more efficient than lead-acid alternatives, still require further advancements in energy storage to meet the demands of urban cargo vehicles.

### ***Environmental and Economic Impact***

Several studies indicate that the environmental and economic advantages of electric cargo vehicles far outweigh their initial investment costs. According to studies by Moser and Cross (2020), electric cargo tricycles can reduce transportation costs by as much as 30-40% compared to conventional ICE vehicles, primarily due to lower maintenance and fuel costs.

## **METHODOLOGY**

The methodology for constructing an electric cargo tricycle involves several key steps, including:

1. Design Phase: Detailed CAD modeling of the chassis, cargo area, and powertrain. Material selection is based on weight, strength, and cost considerations.
2. Component Selection: The choice of motor (hub motor vs. mid-drive motor), battery type (Li-ion), and charging system is based on the expected usage scenario (urban roads, payload, and range).
3. Assembly: Assembly of the frame, integration of the motor, and wiring for the battery and control systems.
4. Testing and Validation: Once constructed, the tricycle undergoes real-world testing, focusing on performance (speed, range, load capacity) and safety (braking, stability).
5. Optimization: Based on test results, adjustments are made to improve efficiency, range, and user comfort (Esheya & Awolumate, 2025).

Key considerations included load capacity, battery efficiency, cost, road conditions, and suitability for small-scale logistics common in Nigerian cities and semi-urban areas. The electric cargo tricycle was powered by a rechargeable battery system driving an electric motor through a motor controller, with a reinforced chassis designed to withstand local road conditions. Performance testing showed that the tricycle is suitable for short-distance cargo transportation, particularly for small businesses and informal sector operators.

## **7. RESULTS AND DISCUSSION**

### ***Performance***

The electric cargo tricycle demonstrated excellent performance in urban environments, with a maximum payload capacity of 200 kg and an average range of 80 km on a single charge. The electric motor's 1000W power output was sufficient to navigate both flat and moderately inclined urban roads with ease.

### ***Cost Analysis***

Initial cost analysis indicates that while the construction of the electric cargo tricycle is more expensive than traditional ICE vehicles, the operational cost savings are significant. With an estimated cost reduction of 30% in fuel and maintenance costs, the electric tricycle can offer a return on investment within two to three years of operation.

### ***Environmental Impact***

The electric cargo tricycle produced no tailpipe emissions during testing, offering substantial environmental benefits compared to gasoline-powered alternatives. This aligns with the goals of reducing urban air pollution and supporting sustainable urban transport systems.

## **CONCLUSION**

The study achieved its primary objectives by developing a functional tricycle capable of carrying moderate loads while operating efficiently on electric power. The design process highlighted the

importance of proper material selection, power system sizing, and structural stability to ensure safety and durability. The construction of electric cargo tricycles presents a viable solution to the challenges of urban logistics, including traffic congestion, environmental degradation, and high operational costs. By combining electric propulsion with a robust, lightweight design, these vehicles offer an efficient, eco-friendly alternative for last-mile delivery. Although challenges such as battery life, high initial costs, and infrastructure needs remain, but despite these challenges, the project confirms that electric cargo tricycles offer a sustainable and economical alternative to fossil fuel-based transportation, especially in developing economies seeking to promote green technology and reduce carbon emissions. The long-term benefits of electric cargo tricycles, including reduced emissions and operating costs, make them a promising option for sustainable urban freight.

## RECOMMENDATIONS

Based on the outcomes of this study and prevailing conditions in Nigeria, the following recommendations were made:

11. **Improved Battery Technology:** Adoption of more efficient and durable battery systems, such as lithium-ion or lithium iron phosphate batteries, is recommended to enhance range and lifespan, despite their higher initial cost (Oyedepo, 2019).
12. **Renewable Energy Integration:** Solar-powered charging stations should be encouraged to mitigate the effects of unreliable grid electricity and reduce dependence on fossil-fuel-generated power (Akinbami & Lawal, 2020).
13. **Local Manufacturing and Assembly:** Government and private sector investment in local production and assembly of electric tricycles and components would reduce costs, create jobs, and improve maintenance accessibility (Ogbonna et al., 2025).
14. **Policy Support and Incentives:** Regulatory support, import duty waivers on electric vehicle components, and financial incentives for manufacturers and users would accelerate adoption (Federal Ministry of Transportation, 2021).
15. **Technical Training and Awareness:** Capacity-building programs should be introduced to train technicians and engineers in electric vehicle technology, ensuring sustainability and proper maintenance (Ituma & Esheya, 2024).
16. **Further Research and Field Testing:** Extended testing under varying Nigerian road, climate, and load conditions is recommended to improve durability, safety, and overall performance.

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